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The key practical implications of this study are that higher job demands and lower autonomy increase the risk of sickness absence among persons with common chronic health problems, and thus that focus on these work-related factors should be central in the promotion of sustainable employability.

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Key terms: adjustment latitude; autonomy; chronic health problem; health; health; health problem; interaction; job control; job demand; longitudinal study; older employee; older worker; physical workload; productivity loss; sickness absence; sickness absence; support; sustainable employability; work factor; work-related factor

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Original article

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Do work factors modify the association between chronic health problems and sickness absence among older employees?

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Objectives The aim of this study was to (i) assess how common chronic health problems and work-related factors predict sickness absence and (ii) explore whether work-related factors modify the effects of health problems on sickness absence.

Methods A one-year longitudinal study was conducted among employed persons aged 45–64 years from the Study on Transitions in Employment, Ability and Motivation (N=8984). The presence of common chronic health problems and work-related factors was determined at baseline and self-reported sickness absence at one-year follow-up by questionnaire. Multinomial multivariate logistic regression analyses were conducted to assess associations between health, work factors, and sickness absence, and relative excess risk due to interaction (RERI) techniques were used to test effect modification.

Results Common health problems were related to follow-up sickness absence, most strongly to high cumulative sickness absence (>9 days per year). Baseline psychological health problems were strongly related to high sickness absence at follow-up [odds ratio (OR) 3.67, 95% confidence interval (95% CI) 2.80–4.82]. Higher job demands at baseline increased the likelihood of high sickness absence at follow-up among workers with severe headaches [RERI 1.35 (95% CI 0.45–2.25)] and psychological health problems [RERI 3.51 (95% CI 0.67–6.34)] at baseline. Lower autonomy at baseline increased the likelihood of high sickness absence at follow-up among those with musculoskeletal [RERI 0.57 (95% CI 0.05–1.08)], circulatory [RERI 0.82 (95% CI 0.00–1.63)], and psychological health problems [RERI 2.94 (95% CI 0.17–5.70)] at baseline.

Conclusions Lower autonomy and higher job demands increased the association of an array of common chronic health problems with sickness absence, and thus focus should be placed on altering these factors in order to reduce sickness absence and essentially promote sustainable employability.

Key terms adjustment latitude; autonomy; interaction; job control; job demand; longitudinal study; older worker; physical workload; productivity loss; support; sustainable employability; work-related factor.

Due to the ageing workforce and decreasing birth rates, it has become crucial to ensure older employees work productively and in good health for longer. Alongside ageing, health problems occur more often and in turn work ability can decrease (1). Poor health can lead to reduced productivity in terms of productivity loss at work, increased sickness absence, or exit from the workforce (2–4). The influence that poor health has on sickness absence differs for various types of health problems (3–5). Work-related factors, such as autonomy, social support, and work pressure also influence productivity loss at work and sickness absence (6–9). Past findings indicate that work-related factors, such as autonomy, job satisfaction, physical load, and social support, interact with health problems in their influence on productivity outcomes (10–14).

In accordance with past findings, we hypothesize that favorable factors at work such as high support, high

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autonomy, low job and emotional demands, and low physical load can help employees with health problems to remain productive at work and avoid or reduce sickness absence. Findings from past qualitative research (15, 16) support the idea that work-related factors modify the effect of health on sickness absence, but quantification of this occurrence is still lacking in the literature. Understanding the effect of work on the influence of poor health on sickness absence has important practical implications because health problems may not always be solved, but work-related factors are amendable.

Since past studies have shown that different health problems affect sickness absence to a different extent (3, 5), it is possible that effect modification of work-related factors also differs per health condition. We hypothesize that health problems will cause sickness absence if unfavorable work factors are present that trigger or aggravate the health problems or that interfere with functioning. For example, psychosocial work factors such as emotional demands and lack of support could especially modify the effects of psychological health problems on sickness absence, whereas workers with musculoskeletal disorders in physically demanding jobs may experience more limitations at work and, thus, are more likely to call in sick. Gaining such problem-specific insight is essential for the development of tailored interventions for sustainable employability, defined as maintaining a high work productivity in good health. The goals of this study were to (i) assess how health problems and work-related factors predict sickness absence and (ii) investigate whether and to what extent work-related factors modify the effects of common health problems on sickness absence.

Methods

Study design

A prospective study with a one-year follow-up was conducted within the longitudinal Study on Transition in Employment, Ability, and Motivation (STREAM) (17). In STREAM, a stratified sample of Dutch citizens aged 45–64 years complete annual online questionnaires on health, job and personal characteristics, work ability, productivity, and transitions in employment. The current study used STREAM data from 2010 (baseline) and 2011 (follow-up). In 2010, 15 118 individuals participated (response 71%), with comparable participation in the four age groups sampled: 45–49, 50–54, 55–59, and 60–64 years. In 2011, 12 430 individuals participated again in STREAM (82%). As our research questions pertained to work-related factors that are specific to workplace settings, we excluded participants if they underwent a transition in work status (employed, self-employed, not employed) between baseline and follow-up (N=1075), were self-employed both years (N=728), or not employed both years (N=1474). Of the remaining participants, 169 persons were excluded because of incomplete data, resulting in a total inclusion of 8984 participants in this study.

The Medical Ethical Committee of the Free University of Amsterdam Medical Center declared that the Medical Research Involving Human Subjects Act does not apply to the STREAM study. The Medical Ethical Committee had no objection to the execution of this research. In the information that accompanied the online questionnaire, it was emphasized that (i) the privacy of participants was guaranteed, (ii) all answers to the questions were anonymous and would be treated confidentially, and (iii) all data were stored in secured computer systems.

Sickness absence

Sickness absence was assessed at baseline and at follow-up with the open question: "How many work days have you, during the past twelve months, been absent due to sickness?" Three categories of cumulative sickness absence were made: none (0 days), low (1–9 days), and high (>9 days).

Health problems

The occurrence of various health problems at baseline was assessed with the question: "Do you [currently] have one or more of the following chronic diseases, disorders, or handicaps?" (18). Of the 13 answer options, the following 7 categories were made: musculoskeletal disorders (MSD), migraine or severe headaches, circulatory diseases, respiratory diseases, digestive problems, diabetes, and psychological complaints. These health categories were not mutually exclusive. Multimorbidity was defined as the presence of ≥2 health problems.

Work-related factors

Studied work-related factors included: autonomy, support, job demands, emotional demands at work, and physical workload. Autonomy was measured with five items derived from the Job Content Questionnaire (JCQ) about: making decisions, deciding the order of and speed of conducting tasks, having to find solutions, and being able to take time off (Cronbach's alpha=0.78) (19). Job demands, measured with four JCQ items, consisted of how fast, much, hard, and hectic an individual's work is (Cronbach's alpha=0.87) (19). Support was measured with four items from the Copenhagen Psychosocial Questionnaire (COPSOQ) concerning whether colleagues and supervisors are

willing to help and listen to work-related problems (Cronbach's alpha=0.81) (20, 21). Emotional demands at work were also assessed with three items derived from the COPSOQ about emotionally difficult situations, emotional demands, and emotional involvement at work (Cronbach's alpha=0.85) (20, 21). Physical workload was assessed with five items from the Dutch Musculoskeletal Questionnaire on force exertion, static load (standing, posture, kneeling), and vibration (using tools or machines that cause vibration) (Cronbach's alpha=0.86) (22). All work-related factor items had 5-point answer scales ranging from 1=(almost) never to 5=always. These scales were dichotomized based on the sample distribution (median values). Categories suspected of having the lowest risk for sickness absence were used as reference categories (23).

Covariates

Age, gender, and educational level were incorporated in this study as covariates. The highest level of education attained was categorized into three groups: low (lower general secondary educational, preparatory secondary vocational education), medium (intermediate vocational training, higher general secondary education, pre-university education), and high (higher vocational education, university education).

Statistical analysis

Descriptive statistics were used to report on general characteristics of the study population. Multinomial logistic regression analyses were conducted to study associations between health problems and work-related factors as independent variables at baseline with the occurrence of cumulative sickness absence during 12-month follow-up, distinguishing none (0 days) (reference), low (1–9 days), and high (>9 days) cumulative sickness absence. Odds ratios (OR) and their corresponding 95% confidence intervals (95% CI) were calculated. First, in model 1, analyses were conducted for each independent variable separately, adjusting for age, gender, and education, since these individual characteristics were significantly related to sickness absence. Thereafter, a multivariate analysis (model 2) using an enter method was conducted, incorporating the work-related factors, health problems, and covariates that had a significant association with either low or high cumulative sickness absence in model 1. This procedure allows for a direct comparison between determinants of low and high sickness absence. Lastly, in model 3, baseline sickness absence was also added to the multivariate model, categorized the same way as follow-up sickness absence. This model focuses on incidence rather than occurrence of sickness absence as the dependent variable. As multimorbidity was defined on the basis of separate health problems, this variable was not included in either models 2 or 3 in order to avoid over adjustment.

To study whether and to what extent work-related factors modified the effect of health problems on sickness absence, interaction effects were analyzed by calculating relative excess risk due to interaction (RERI) terms and their 95% CI, using the delta method in Excel (Microsoft Corp, Redmond, WA, USA) (23–25). RERI are calculated with OR as estimates of relative risks (RR), $\text{RERI} = \text{OR}_{(\text{health problem + unfavorable work factor})} - \text{OR}_{(\text{health problem + favorable work factor})} - \text{OR}_{(\text{no health problem + unfavorable work factor})} + 1$ (23, 24). When RERI is not equal to zero, an additive interaction is present; RERI can range from negative infinity (negative interaction, less than additivity) to positive infinity (positive interaction, more than additivity) (23). Through this analysis the per cent increase in likelihood of sickness absence for persons with a health problem and unfavorable work-related factors as opposed to those with the health problem and favorable work-related factors was also calculated $[((\text{OR}_{\text{health problem + unfavorable work factor}} - \text{OR}_{\text{health problem + favorable work factor}})/ \text{OR}_{\text{health problem + favorable work factor}}) \times 100]$. Variables that were significantly related ($P<0.05$) to sickness absence in the multivariate analysis (model 2) were incorporated in the effect modification analyses. Analyses were done using SPSS, version 20, (SPSS Institute, Chicago, IL, USA) and Excel.

Results

Descriptive information

The study population characteristics can be found in table 1. Loss-to-follow-up was 18% for both men and women, 20% and 17% for the youngest and the oldest age groups, respectively, and 18% and 16% for low and high educated persons, respectively. Persons with high baseline cumulative sickness absence had a loss-to-follow-up of 18%, this was 17% for those with a low sickness absence.

Additional analyses showed that, at baseline, men were less likely than women to have cumulative sickness absence of 1–9 days [OR 0.87 (95% CI 0.79–0.96) and of >9 days [OR 0.90 (95%CI 0.80–1.01)]. The oldest age group had less sickness absence of 1–9 days [OR 0.58 (95% CI 0.50–0.67)] but similar sickness absence of >9 days [OR 0.94 (95% CI 0.79–1.13)] when compared to the youngest age group. Lower educated persons were more likely to have high [OR 1.43 (95% CI 1.24–1.65)] and less likely to have low [OR 0.76 (95% CI 0.67–0.86)] cumulative sickness absence. All covariates were included in the remaining analyses.

Table 1. Demographic, health, work, and sickness absence descriptive information among N=8984 employed older (aged 45–64) individuals.

Variable	%	N
Age (mean=54, min=45, max=64 years)		
45–49	25.4	2285
50–54	26.6	2387
55–59	29.8	2681
60–64	18.2	1631
Gender (female)	43.9	3941
Educational level		
Low	26.6	2393
Medium	39.0	3507
High	34.3	3084
Health problems		
Musculoskeletal	32.1	2880
Circulatory	9.6	861
Severe headaches	8.3	742
Respiratory	7.3	659
Diabetes	6.6	592
Digestive	5.9	529
Psychological	3.9	354
Multimorbidity	11.9	1067
No health problem	42.2	3793
Work-related factors (median)		
Lower autonomy (4.00)	47.7	4282
Lower support (3.71)	35.4	3176
Higher job demands (3.00)	49.5	4446
Higher emotional demands (2.67)	36.8	3303
Higher physical workload (1.40)	47.6	4278
Baseline cumulative sickness absence		
None (0 days)	53.0	4762
Low (1–9 days)	28.7	2585
High (>9 days)	18.2	1637
Follow-up cumulative sickness absence		
None (0 days)	55.2	4960
Low (1–9 days)	27.3	2450
High (>9 days)	17.5	1574

More than fifty per cent of the participants were not absent during the one-year follow-up, about 27% had a short cumulative sickness absence (1–9 days) and about 17% had high cumulative sickness absence (>9 days) within the past year. The prevalence of sickness absence at baseline was 47% and 45% at follow-up. For both low and high sickness absence, the recurrence was approximately 46% and the incidence approximately 17%.

By far the most frequently present health problem at baseline was a MSD (32.1%), followed by circulatory diseases (9.6%), and severe headaches (8.3%). The same pattern was seen in the frequency of health problems at follow-up, the maximum change in prevalence between the two assessments was 0.8%. Multiple health problems were present in 11.9% of the study population at baseline, often combinations of MSD with: migraines (4.0%), heart disease (3.4%), and respiratory problems (3.2%).

All work-related factors at baseline were marginally interrelated (Spearman's rho correlations <0.27). Work-related factors were relatively stable at baseline and follow-up and the proportion of persons with recurrent (un)favorable work factors ranged from 69% (emotional demands) to 87% (physical work load).

Health problems and sickness absence

Figure 1 depicts the distribution of sickness absence among persons with common health problems. High sickness absence was most common among persons with psychological complaints (38%). Table 2 shows that the presence of a health problem at baseline was related to an increased likelihood of sickness absence during follow-up (models 1 and 2). The relationship between health problems and sickness absence was stronger with high than low cumulative sickness absence. After adjustment for baseline sickness absence (model 3), all health problems remain statistically significantly associated with high sickness absence. Overall, the associations between health problems and sickness absence were marginally reduced after adjustment for baseline sickness absence (maximum OR reduction 26%).

Work-related factors and sickness absence

All work-related factors were related to follow-up cumulative sickness absence (table 2). After adjusting for age, gender, educational level, and health problems, lower autonomy [OR 1.30 (95% CI 1.15–1.47)] and higher job demands [OR 1.20 (95% CI 1.06–1.36)] were related to high cumulative sickness absence (model 2). Adjustment for baseline sickness absence decreased these associations (OR) by <10% (model 3).

Interaction work-related factors and health

Figure 2 shows that lower autonomy and higher job demands were important work-related factors that interacted with common health problems. Interaction effects were not observed for low cumulative sickness absence (for numerical details see supplementary table A in the Appendix). Within persons with musculoskeletal [RERI 0.57 (95% CI 0.05–1.08)], circulatory [RERI 0.82 (95% CI 0.00–1.63)], psychological [RERI 2.94 (95% CI 0.17–5.70)], and a multimorbidity of health problems [RERI 1.43 (95% CI 0.48–2.38)], lower autonomy increased the likelihood of high cumulative sickness absence (figure 2 and table 3).Within persons with a multimorbidity of health problems, lower autonomy increased the likelihood of high cumulative sickness absence by 78%. For those individuals with psychological health complaints, this increase in likelihood of high cumulative sickness absence was even higher, at 94% (see table 3).

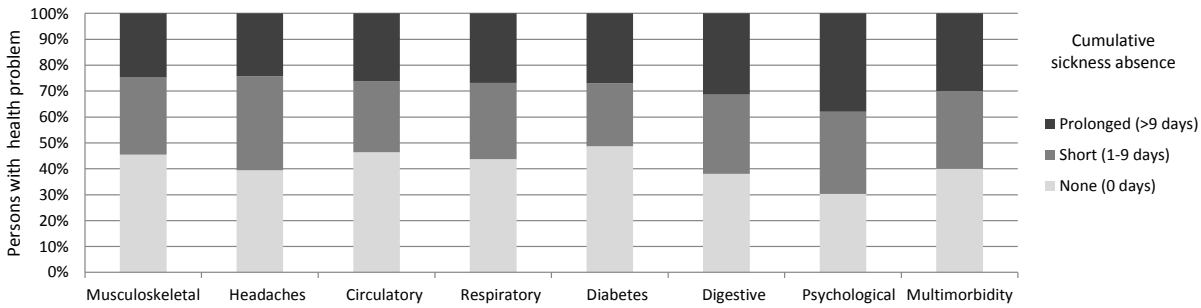


Figure 1. Occurrence of self-reported sickness absence over the past 12 months amongst older (aged 45–64) employees with common health problems (N=8984).

Table 2. Associations between health, work-related factors, and cumulative self-reported sickness absence in a sample of older (aged 45–64) employees (N=8984). [MSD=musculoskeletal disorders; OR=odds ratio; 95% CI=95% confidence interval]

	Model 1 [a]				Model 2 [b]				Model 3 [c]			
	Low (1–9 days)		High (>9 days)		Low (1–9 days)		High (>9 days)		Low (1–9 days)		High (>9 days)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Work-related factors												
Low autonomy	1.09	0.99–1.20	1.43	1.27–1.60	1.11	1.00–1.23	1.30	1.15–1.47	1.05	0.94–1.17	1.18	1.04–1.35
Low support	0.88	0.80–0.98	1.05	0.93–1.18	0.85	0.76–0.94	0.94	0.84–1.07	0.87	0.78–0.97	0.99	0.87–1.13
High job demands	1.11	1.00–1.22	1.32	1.17–1.48	1.09	0.98–1.21	1.20	1.06–1.36	1.06	0.95–1.18	1.13	0.99–1.29
High emotional demands	1.12	1.01–1.24	1.32	1.17–1.49	1.07	0.96–1.19	1.08	0.95–1.23	1.06	0.95–1.19	1.07	0.93–1.23
High physical load	0.87	0.79–0.96	1.24	1.10–1.39	0.80	0.72–0.89	1.06	0.93–1.20	0.80	0.72–0.90	1.04	0.91–1.19
Health problems												
MSD	1.55	1.40–1.73	2.26	2.00–2.54	1.48	1.33–1.65	1.98	1.75–2.24	1.32	1.18–1.48	1.63	1.43–1.86
Headaches	1.84	1.54–2.19	2.02	1.66–2.46	1.68	1.41–2.01	1.59	1.29–1.95	1.47	1.22–1.76	1.31	1.05–1.64
Circulatory	1.34	1.13–1.60	1.96	1.64–2.34	1.32	1.11–1.57	1.79	1.49–2.16	1.14	0.95–1.36	1.37	1.12–1.68
Respiratory	1.38	1.14–1.67	2.07	1.69–2.52	1.28	1.06–1.56	1.75	1.42–2.15	1.11	0.91–1.36	1.39	1.11–1.74
Digestive	1.68	1.36–2.08	2.76	2.23–3.43	1.45	1.17–1.80	2.07	1.66–2.59	1.22	0.97–1.54	1.62	1.27–2.07
Diabetes	1.09	0.88–1.34	1.77	1.44–2.17	1.03	0.83–1.27	1.55	1.25–1.93	0.94	0.75–1.17	1.36	1.07–1.71
Psychological	2.16	1.64–2.83	4.34	3.34–5.65	1.98	1.51–2.61	3.67	2.80–4.82	1.45	1.09–1.94	2.28	1.70–3.07
Multimorbidity	1.53	1.31–1.79	2.70	2.30–3.16								

[a] Analyses adjusted for covariates (ie, age, gender, education).
[b] Analysis adjusted for covariates, work-related factors, and all health problems except multimorbidity.
[c] Analysis adjusted for covariates, work-related factors, all health problems except multimorbidity, and baseline sickness absence.

Higher job demands also strengthened the association of severe headaches, psychological, and a multimorbidity of health problems with high cumulative sickness absence. For persons with psychological complaints, higher as opposed to lower job demands were associated with a relative excess risk of high sickness absence of 3.51 (95% CI 0.67–6.34), the presence of higher job demands increased the likelihood of high cumulative sickness absence by 115% (see table 3).

Discussion

The presence of common health problems at baseline was associated with sickness absence at one-year follow-up, especially of >9 days. Lower autonomy and higher job demands solely related to the likelihood of high cumulative sickness absence and interacted with various health problems. Among persons with psychological complaints, MSD, severe headaches, circulatory problems, and a multimorbidity of health problems at baseline, lower autonomy and higher job demands increased the likelihood of high cumulative sickness absence at follow-up.

In this study the modifying effects of autonomy and job demands on the relation between commonly occurring chronic health problems and sickness absence have been explicitly quantified through interaction effect analyses. The proportion of the combined effects of the work factors and health problems on sickness absence that was due to the interaction [attributable proportion (AP)=RERI/$OR_{\text{health problem + unfavorable work factor}}$] ranged from 0.18 (MSD × autonomy) to 0.50 (psychological × job demands) (pos-

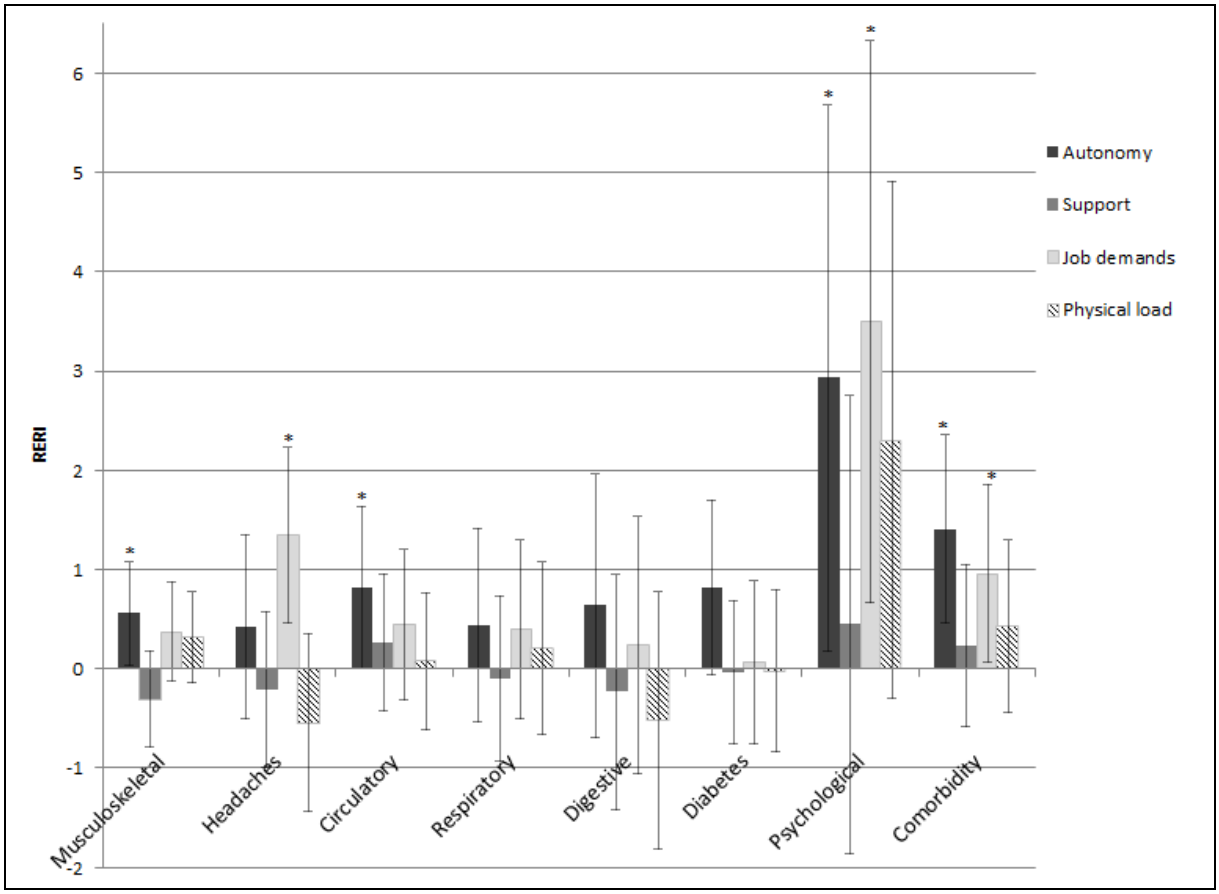


Figure 2. Relative excess risk due to interaction (RERI) of health and work-related factors on high (>9 days) cumulative sickness absence during one-year follow-up, after adjustment for age, gender, and education.*Statistically significant P<0.05.

sible AP range= -1–1) (23). The risk of lower autonomy and higher job demands for sickness absence has been found in other, mostly cross-sectional, studies (9, 11, 12). Results from past findings also suggest that work-related factors play a role in the health-productivity loss association, but have looked solely at physical health problems instead of at a wide array of common health problems as the current study does (10, 13). Because autonomy and job demands are such important effect modifiers, it is an imperative that employers focus on these work-related factors in promoting sustainable employability.

Of all health problems, psychological health complaints had the strongest association with sickness absence after adjustment for baseline sickness absence (OR 2.28). This result is in line with findings that suggest that specifically bipolar, major depressive, and panic disorders are strongly associated with sickness absence on the population level (5). A recent study has also found that an increase in psychological health problems amongst older employees leads to disability retirement (3).

Psychological, physical, and a multimorbidity of health problems all interacted with job demands and autonomy in their associations with sickness absence. Work-related factors can modify the effect of health problems on sickness absence by supporting active and successful coping and adaptations, that will enable an individual to keep working productively as was found in a recent interview study also carried out within STREAM (16). It may be hypothesized that psychosocial work-related factors are important because they allow an individual to exert control over how his or her work is conducted and inherently how adjustments therein can be made. Aspects of the Illness Flexibility model, and findings from the aforementioned interview study, are in line with this (12). The results also point to the relevance of internal motivation as a potential prerequisite of making such alterations (12, 16). Future research should thus corroborate whether favorable work factors are sufficient in reducing sickness absence or whether motivational factors further moderate this relationship.

Because physical workload was not associated with high sickness absence, some extra explorative analyses were conducted. Separate analyses for each item of physical load showed comparable results, hence, the

Table 3. Interaction effects of work-related factors and health on high cumulative sickness absence, after adjustment for age, gender, and education (N=6534). Excluding persons with low cumulative sickness absence (N=2450). [MSD=musculoskeletal disorders; OR=odds ratio; 95% CI=95% confidence interval.]

Health problem	Work-related factor	N	OR	95% CI	RERI	95% CI
MSD	Autonomy				0.57	0.05–1.08
Not present	Higher	2446	1.00			
Not present	Lower	2069	1.37	1.18–1.59		
Present	Higher	979	2.19	1.84–2.60		
Present	Lower	1040	3.12	2.65-3.69		
Severe headaches	Job demands				1.35	0.45–2.25
Not present	Lower	3121	1.00			
Not present	Higher	2942	1.25	1.11–1.41		
Present	Lower	222	1.52	1.12–2.06		
Present	Higher	249	3.12	2.39–4.07		
Circulatory disorders	Autonomy				0.82	0.00–1.63
Not present	Higher	3102	1.00			
Not present	Lower	2806	1.39	1.23–1.57		
Present	Higher	323	1.76	1.36–2.28		
Present	Lower	303	2.97	2.32–3.79		
Psychological complaints	Autonomy				2.94	0.17–5.70
Not present	Higher	3320	1.00			
Not present	Lower	2973	1.38	1.23–1.55		
Present	Higher	105	3.53	2.38–5.24		
Present	Lower	136	6.85	4.78–9.82		
	Job demands				3.51	0.67–6.34
Not present	Lower	3232	1.00			
Not present	Higher	3061	1.27	1.13–1.43		
Present	Lower	111	3.27	2.22–4.80		
Present	Higher	130	7.04	4.86–10.21		
Multi-morbidity	Autonomy				1.43	0.48–2.38
Not present	Higher	3070	1.00			
Not present	Lower	2707	1.34	1.18–1.52		
Present	Higher	353	2.28	1.80–2.89		
Present	Lower	404	4.05	3.26–5.03		
	Job demands				1.01	0.11–1.91
Not present	Lower	2994	1.00			
Not present	Higher	2785	1.26	1.11–1.44		
Present	Lower	349	2.43	1.92–3.08		
Present	Higher	406	3.70	2.98–4.60		

scale construction cannot explain the lack of an association. Further, because the multivariate analyses corrected for educational level it is possible that overcorrection occurred, but when the analyses were repeated without the inclusion of educational level, the same non-significant effects were found. Past findings on the role of physical load in productivity loss have also been inconclusive (4). Because the participants in STREAM are ≥45 years of age, it is possible that persons who worked in jobs that required a higher physical load – but could not handle this due to poor health – had already switched careers at a younger age, and thus the healthy worker effect might explain our findings.

There are limitations in this study to be mentioned. Because sickness absence was measured at both baseline and follow-up, we assessed the association of health and work-related factors with both incidence (model 3) and occurrence (models 1 and 2, interaction analyses) of sickness absence. Since sickness absence in both models 2 and 3 had similar determinants, the interaction effect analyses were limited to the occurrence of sickness absence because the current study had less discriminatory power to also investigate interaction for incident cases.

Effect modification was assessed with RERI interaction effect analyses. Based on our hypotheses, we presumed that work-related factors modified the effects of health on sickness absence. A reversed scenario, in which health moderates the effects of work factors on sickness absence, cannot be excluded on the basis of interaction effect analyses. However, our primary hypothesis was that health problems precede sickness absence, as presented in the introduction.

As many variables were included in the analyses, there is a possibility of finding effects per chance. We, however, chose to analyze the effects of many different common health problems and work-related factors on sickness absence in order to assess consistent patterns and effects; autonomy and job demands were important effect modifiers for a variety of health problems.

Work-related factors were dichotomized as higher or lower on the basis of median values because scales were ordinal and some scores were much more frequent than others, for example low physical workload. Making different groups for each of the 5-point answers would have led to a large reduction of power. Dichotomization had the potential downside that participants were categorized as higher or lower, which may not have reflected their scores on the scale labels. For example, the median cut-off point for higher physical load was 1.40, which is according to the labels everything but "(almost) never"; thus "rarely", "sometimes", "often", and "(almost) always" were clustered together. To control the accuracy of findings, analyses were done comparing participants with the lowest and highest tertile work-related factor scale scores. Because these analyses resulted in very similar findings to the median value analyses, we chose to keep the median as a cut-off point.

The self-reported health problem item may be flawed in that the health problems were a combination of disorders and complaints, and the question did not specify whether the problem was diagnosed by a physician. Nonetheless, the health problems were clear predictors for sickness absence. Self-reporting of sickness absence over a 12-month period has been found to concur with registered sickness absence. As sickness absence days increase, however, the accuracy of self-reporting decreases (27, 28). Since high sickness

absence was defined by any number of days >9 in our study, we assume that such inaccuracies did not influence our findings.

Based on findings from the current study, we conclude that autonomy and job demands have a moderating effect on the association between common chronic health problems and sickness absence. Encouraging lower job demands and higher autonomy can help to reduce sickness absence in spite of the presence of health problems. Therefore, work-related factors are deemed to be essential in the promotion of sustainable employment and relevant for interventions for older employees with health problems.

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Supplementary table A. Effect modification, expressed as relative excess risk due to interaction (RERI), of work-related factors on the influence of health on cumulative sickness absence (SA) in older (aged 45–64) employees (N=8984). Adjusted for age, gender, and educational level. [95% CI=95% confidence interval].

Level of SA [a] by health problem	Autonomy		Support		Job demands		Physical load	
	RERI	95% CI	RERI	95% CI	RERI	95% CI	RERI	95% CI
MSD								
Low	0.24	-0.06–0.53	-0.02	-0.31–0.27	-0.13	-0.45–0.19	0.23	-0.02–0.47
High	0.57	0.05–1.08	-0.30	-0.79–0.19	0.37	-0.12–0.87	0.33	-0.13–0.80
Severe headaches								
Low	-0.23	-0.88–0.43	0.24	-0.36–0.85	0.48	-0.20–1.15	-0.18	-0.78–0.42
High	0.42	-0.51-1.35	-0.21	-0.98–0.57	1.35	0.45–2.25	-0.53	-1.43–0.36
Circulatory								
Low	0.14	-0.34–0.62	-0.10	-0.54–0.34	0.21	-0.27–0.69	-0.16	-0.59–0.27
High	0.82	0.00–1.63	0.28	-0.42—0.97	0.44	-0.32–1.21	0.08	-0.66–0.83
Respiratory								
Low	0.51	-0.05–1.06	-0.20	-0.69–0.29	0.16	-0.38–0.71	0.26	-0.22–0.74
High	0.46	-0.51–1.44	-0.12	-0.93–0.69	0.43	-0.47–1.33	0.19	-0.69–1.06
Digestive								
Low	-0.75	-1.52–0.03	-0.12	-0.80–0.56	-0.09	-0.84–0.67	-0.20	-0.87–0.47
High	0.64	-0.69–1.98	-0.23	-1.42–0.96	0.24	-1.07–1.55	-0.52	-1.82–0.78
Diabetes								
Low	0.16	-0.32–0.65	-0.10	-0.53–0.34	0.31	-0.17–0.80	0.08	-0.35–0.50
High	0.82	-0.06–1.70	-0.08	-0.80–0.63	0.07	-0.76–0.89	-0.01	-0.82–0.79
Psychological								
Low	1.09	-0.15–2.32	-0.02	-1.13–1.09	0.31	-0.95–1.56	0.55	-0.56–1.66
High	2.94	0.17–5.70	0.46	-1.85–2.76	3.51	0.67–6.34	2.30	-0.30–4.90
Multimorbidity								
Low	0.34	-0.14–0.82	-0.03	-0.47–0.42	0.17	-0.34–0.68	0.15	-0.29–0.58
High	1.43	0.48–2.38	0.21	-0.60–1.02	1.01	0.11–1.91	0.41	-0.46–1.29

[a] Low: 1–9 days, high: >9 days.